003610543
WPI Acc No: 1983-F8739K/198318
XRPX Acc No: N83-076287

Balancing arrangement for reciprocating engine - comprises two balancing links pivoted to crankshaft and constrained by guide links for movement normal to crankshaft axis

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Number of Countries: 006 Number of Patents: 005
Basic Patent:

Patent No	Kind	Date	Applicat No	Kind	Date	Week	
EP 77634	A	19830427	EP 82305435	A	19821013	198318	B

Priority Applications (No Type Date): GB 8131076 A 19811015
Cited Patents: DE 2423134; DE 3040686; EP 58785; FR 319525; FR 840855; GB 1141189; GB 1242259; GB 909435; US 1794715
Designated States (Regional): DE; FR; GB; IT

Abstract (Basic): EP 77634 A

The reciprocating engine has a pair of balancing links (17,17') pivotally attached to the crankshaft (14) to act as balancing weights. The links are pivotally attached to guide links (19,19') by pivots (20,20'), the other ends of the guide links being pivotally attached to fixed pivots (21,21') carried on the engine crankcase (22).

The guide links extend in opposite directions from one another relative to the balancing links (17,17'). The balancing links are constrained by the guide links to follow a path normal to the axis of the crankshaft and in opposition to the pistons (10).

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Title Terms: BALANCE; ARRANGE; RECIPROCAL; ENGINE; COMPRISE; TWO; BALANCE; LINK; PIVOT; CRANKSHAFT; CONSTRAIN; GUIDE; LINK; MOVEMENT; NORMAL; CRANKSHAFT; AXIS
Derwent Class: Q63
International Patent Class (Additional): F16F-015/26
File Segment: EngPI

(19) Europäisches Patentamt
Eur pean Patent Office
Office europé n des brevets

(11) Publication number: **0 077 634**
A1

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: 82305435.8

(51) Int. Cl.³: F 16 F 15/26

(22) Date of filing: 13.10.82

(30) Priority: 15.10.81 GB 8131076

(43) Date of publication of application:
27.04.83 Bulletin 83/17

(84) Designated Contracting States:
DE FR GB IT

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(54) **Means for reducing vibration in reciprocating engines.**

(57) A reciprocating engine, preferably a high speed internal combustion engine, includes means for reducing vibration.

The engine has at least one piston 10, a connecting rod 12 connected at one end to the piston and at the other end to a crankshaft 14. A pair of balancing links 17, 17' are pivotally mounted on the crankshaft and guide links 19, 19' constrain the balancing links to follow paths generally normal to the crankshaft axis and in opposition to the piston.

The guide links extend in opposite directions and are attached to the balancing links and to a fixed point 22 to balance out the vibrational forces of the engine.

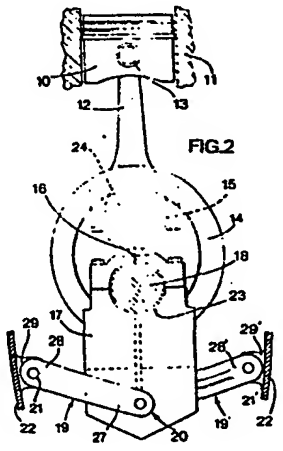


FIG.2

EP 0 077 634 A1

MEANS FOR REDUCING VIBRATION IN RECIPROCATING ENGINES. 0077634

This invention relates to means for reducing vibration in reciprocating engines, in particular, but not exclusiv ly, high speed internal ombustion engines.

In our prior European Patent Application No. 81300671.5 we have described and claimed a reciprocating engine having a piston, a connecting rod and a crankshaft to which the connecting rod is attached, the crankshaft pivotally carrying a balancing link the movement of which is guided by a guide link to follow a path generally normal to the crankshaft axis and in opposition to the movement of the piston. The balancing link follows a generally rectilinear path but due to the use of a pivotal guide link the path is in fact arcuate. If the guide link is relatively long the path approximates more to a rectilinear path but the use of a long guide link provides problems in accommodating the link and usually the engine crankcase needs to be extended for this purpose. Moreover if the guide link is relatively short excessive vibration forces of twice running frequency are introduced.

An object of the invention is to provide an improved reciprocating engine of the kind disclosed in said prior application in which the balancing link/guide link configuration is more compact without an increase of vibrational forces.

According to the invention a reciprocating engine comprises at least one piston, a connecting rod connected at one end to the piston, a crankshaft to which the other end of the connecting rod is attached, and a pair of balancing links constituting balancing weights and pivotally mounted on the crankshaft, the balancing links being constrained by a pair of guide links to follow paths generally normal to the axis of the crankshaft and in opposition to the movement of the piston, each guide link being associated with one of the balancing links and the guide links extending in opposite directions to one another for attachment at one end to the associated balancing link and at the other end to a fixed point.

Preferably the balancing links are located side by side on the crankshaft and the points of attachment of the guide links to the balancing links are at the centres of percussion of the balancing links. The centre of percussion is defined by its displacement from the centre of gravity of the balancing link which is a distance which is equal to the square of the polar radius of gyration of the balancing link divided by the distance between the centre of gravity of the balancing link and its point of attachment to the crankshaft as described in our prior European application 81300671.5.

By the use of a pair of balancing links each guided by a guide link extending in opposite directions to one another it is possible to use relatively short guide links because even though the balancing links depart from a rectilinear movement the out of balance inertia forces created are balanced out.

It will be appreciated that each balancing link balances one half of the reciprocating mass of the engine and the balancing arrangement balances the inertia forces of the piston and connecting rod.

Further features of the invention will appear from the following description of an embodiment of the invention given by way of example only and with reference to the drawings, in which:-

Fig. 1 is a schematic side elevation of part of a reciprocating engine in this case a parallel twin internal combustion engine,

Fig. 2 is a section on the line A-A in Fig.1,

Fig.3 is a section corresponding to that of Fig. 2 with the crankshaft displaced through 90° about its axis compared with the crankshaft position of Fig. 2,

Fig. 4 is a plan view of the engine, and

Fig. 5 is a plan vi w of a guide link of the engine of Figs. 1-4.

Referring to the drawings an internal combustion engine is shown which in this case is a parallel twin engine but the invention could equally be applied to other reciprocating engines.

The engine includes a pair of pistons 10 movable to reciprocate in cylinders 11 and each piston is pivotally connected to a connecting rod 12 through a bearing 13. The other ends of the connecting rods 12 are connected to crankpins 24 on a crankshaft 14 through bearings 15.

A pair of balancing links 17 and 17' are pivotally attached to the crankshaft 14 through bearings 23, 23' onto a crankpin 18 located between the crankpins 24. The crankpin 18 is disposed at 180° around a pivot axis 16 of the crankshaft from the crankpins 24.

The balancing links 17 and 17' are pivotally attached to guide links 19 and 19' respectively by pivots 20 and 20'. The other ends of the guide links 19, 19' are pivotally attached to fixed pivots 21, 21' carried on the engine crankcase 22 so that the guide links extend in opposite directions from one another relative to the links 17 and 17'.

The guide links 19, 19' are located side by side on the crankpin 18 so that each is able to pivot independently of the other.

The pivots 20, 20' for the guide links include bearings (not shown) and pivot pins 26, 26'. Each guide link 19, 19' has bifurcated arms 27, 27' (Fig. 5) which locate to the sides of the associated balancing link 17, 17' and are apertured to receive the pins 26, 26'. The arms 27, 27' accommodate the associated balancing link as the crankshaft rotates and each guide link pivots relative to the associated balancing link. At the other end of each guide link 19, 19' the link is also bifurcated to provide arms 28, 28' which pass to either side of lugs 29, 29' on the crankcase 22 and the pivots 21, 21' are in th form f pins passing through the arms 28, 28' and the lugs 29, 29'.

The pivots 20, 20' by which the guide links 19, 19' are attached to the balancing links 17, 17' are located at the centres of percussion of the balancing links, the term 'centre of percussion' being as defined in our prior European application No. 81300671.5. Moreover the configuration of each balancing link/guide link combination is as described in said prior application. Thus the relationship between the connecting rod length and the effective lengths of the balancing links and the guide links is such that:

$$\frac{AB}{BC} \text{ is substantially equal to } \frac{DE}{DC}$$

where:

AB is the distance between the connection B of the connecting rod 12 to the piston 10 and the connection of the connecting rod 12 to the crankpin 24,

BC is the distance between the axis 16 of the crankshaft 14 and the connection of the connecting rod 12 to the crankpin 24,

DE is the distance between the connection 23 of the balancing links 17, 17' to the crankpin 18 and the connection 20 of the guide links 19, 19' to the balancing links 17, 17', and

DC is the distance between the crankshaft axis 16 and the connection 23 of the balancing links 17, 17' to the crankpin 18.

In one important respect, however, the described arrangement is quite different from said prior specification. By the use of a pair of balancing links, and of guide links associated one with each balancing link and extending in opposite directions, each balancing link balances one half of the reciprocating mass of the engine and the components of inertia arising in a direction transverse to the movement of the reciprocating mass due to the non linear movement of the balancing link are balanced. Accordingly the lengths of the guide links are no longer material to the balancing action obtained and relatively shorter guide links can be used. In this way the balancing arrangement

occupies less space in the engine configuration and the guide links can be accommodated in the crankcase without providing an extended crankcase profile.

In Figs. 2 and 3 there are shown two positions adopted by the balancing link 17 during operation of the engine.

In Fig. 2 the pistons 10 are at the top of their strokes in the cylinders 11 (top dead centre position) and the balancing links are in their lowermost position. The pivotal axes of the pistons 10 to connecting rods 12, the crankpins 24 and the crankpins 18 are in alignment and aligned with the crankshaft axis 16. The same applies when the pistons 10 are at the bottom of their strokes (bottom dead centre position) except that the position of the crankpins 24 and 18 are reversed relative to the axis 16.

Intermediate these two positions, for example after the crankshaft has rotated through 90^{0} from the bottom or top dead centre positions, as shown in Fig. 3 the crankpin 18 is displaced to the side of the plane in which the crankshaft axis and the piston lies and the connections 20, 20' of the guide links 19, 19' to the balancing links 17, 17' are displaced equal amounts to opposite sides of said plane. Thus the balancing links are displaced from the vertical in opposite directions in equal amounts thereby balancing the inertia components of the links 17 and 17'.

CLAIMS

1. A reciprocating engine comprising at least one piston (10), a connecting rod (12) connected at one end to the piston, and a crankshaft (14) to which the other end of the connecting rod is attached, characterised by a pair of balancing links (17, 17') constituting balancing weights and pivotably mounted on the crankshaft, the balancing links each being constrained by an associated guide link (19, 19') to follow a path generally normal to the axis (16) of the crankshaft and in opposition to the movement of the piston, the guide links extending in opposite directions to one another for attachment at one end (20, 20') to the associated balancing link and at the other end (21, 21') to a fixed point (22).

2. A reciprocating engine according to claim 1 characterised in that the balancing links (17, 17') are located side by side on the crankshaft (14).

3. A reciprocating engine according to claim 1 or 2 characterised in that the points of attachment (20, 20') of the guide links (19, 19') to the balancing links (20, 20') are at the centres of percussion of the respective balancing links.

4. A reciprocating engine according to any one of the preceding claims characterised in that each balancing link (17, 17') balances one half of the reciprocating mass of the engine.

5. A reciprocating engine according to any one of the preceding claims comprising an engine crankcase (22), characterised in that the balancing links (17, 17') are contained within the crankcase.

6. A reciprocating engine according to any one of the preceding claims wherein the engine is a parallel twin engine having a connecting rod (12) for each piston (10), the connecting rods being attached to the crankshaft (14) through crankpins (24) spaced apart from one another along the crankshaft, characterised in that the balancing links (17, 17') are attached to the crankshaft through a common crankpin (18) located between the connecting rod crankpins (24) for independent pivotal movement relative to one another.

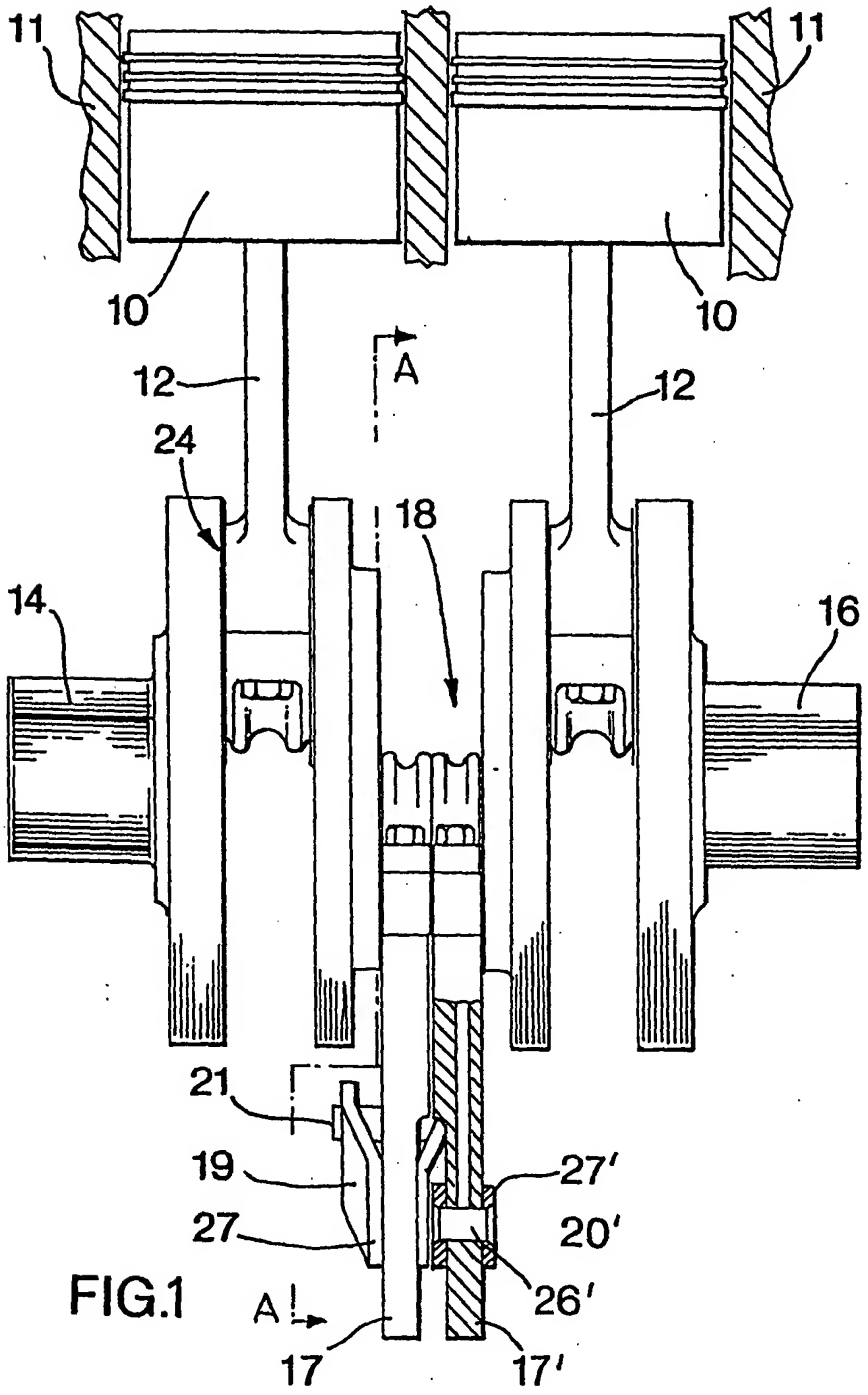


FIG.1

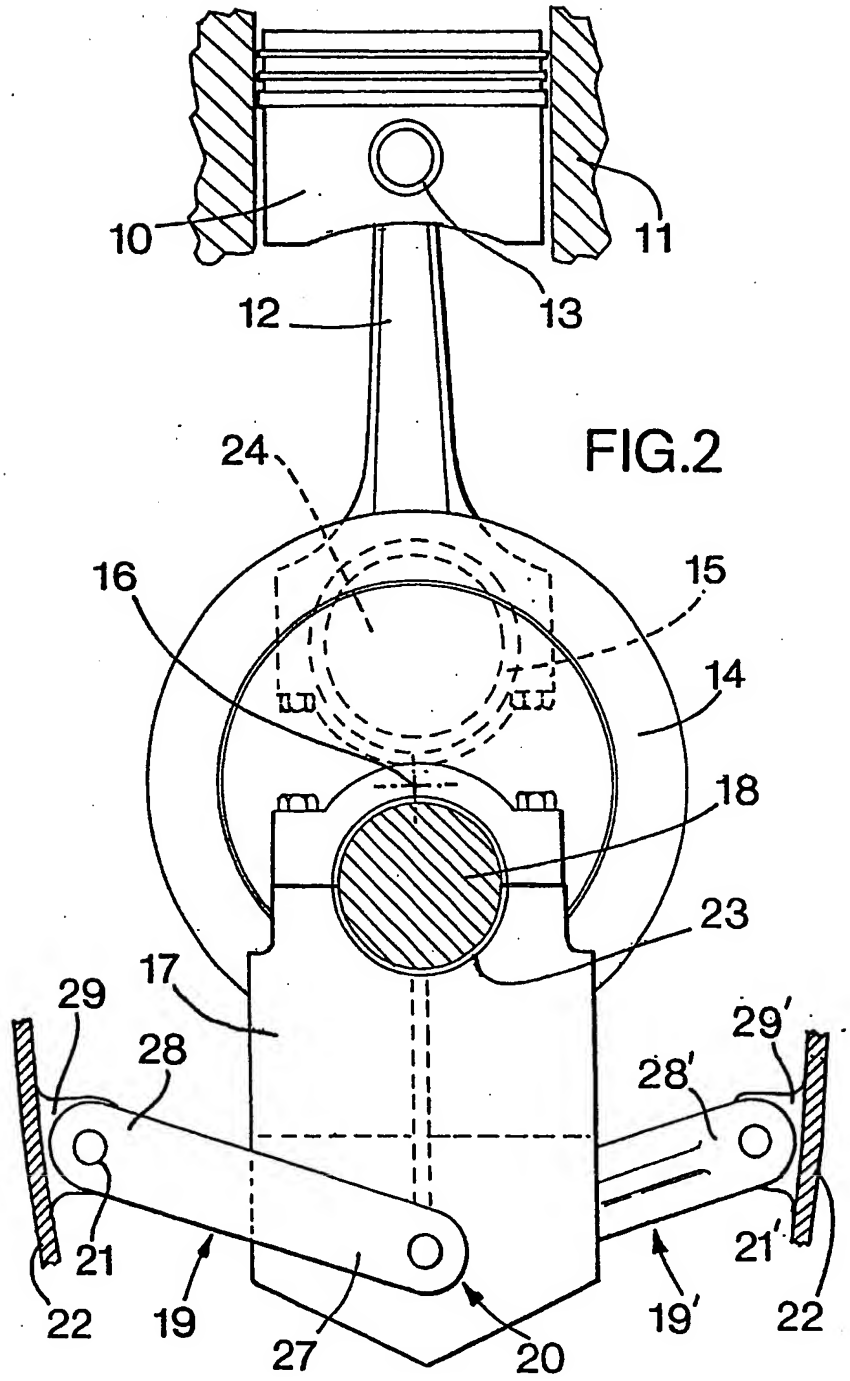


FIG.2

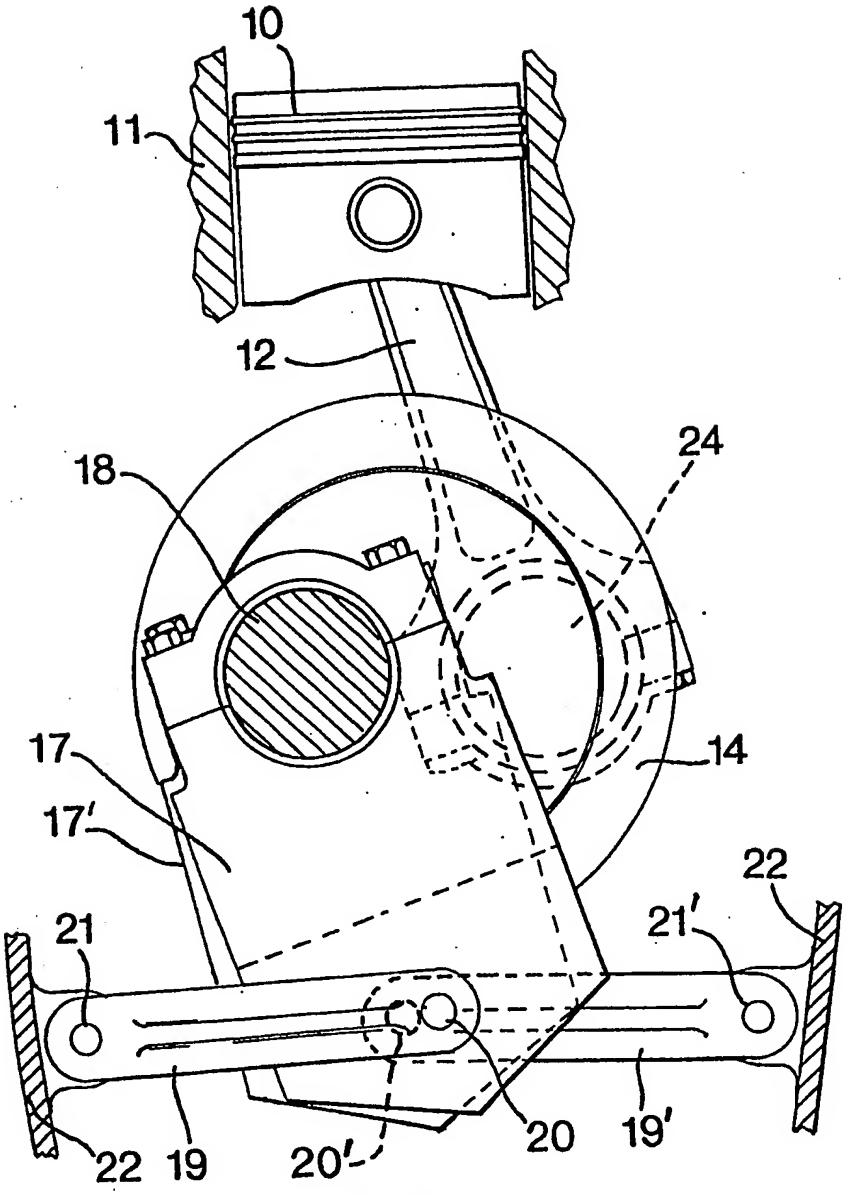


FIG.3

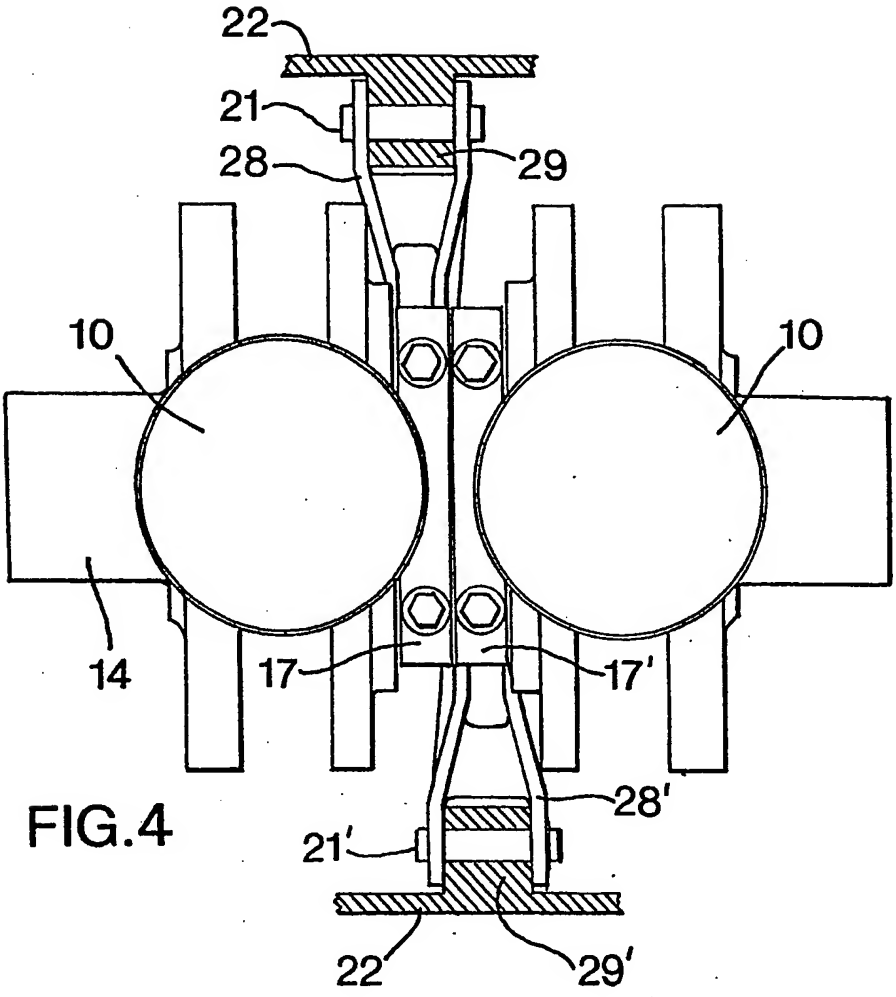
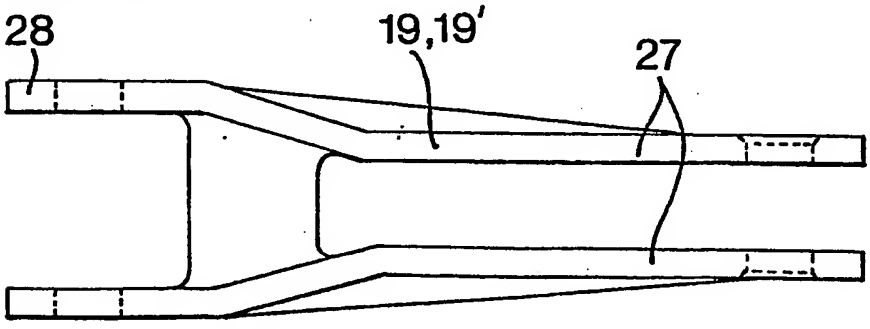


FIG.4

FIG.5



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EUROPEAN SEARCH REPORT

0077634
Application number

EP 82 30 5435

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
P,Y	EP-A-0 058 785 (TRIUMPH MOTORCYCLES (MERIDEN) LTD.) * the whole document *	1-6	F 16 F 15/26
Y	GB-A- 909 435 (M.J. BERLYN) * the whole document *	1-6	
Y	DE-A-2 423 134 (VOLKSWAGENWERK AG) * page 4, lines 14-29 *	1,2,4, 5	
P,Y	DE-A-3 040 686 (VOLKSWAGENWERK AG) * page 6 *	1,2,4, 5	
A	GB-A-1 141 189 (BRIGGS & STRATTON CORP.)	1	TECHNICAL FIELDS SEARCHED (Int. Cl. ³)
A	GB-A-1 242 259 (H.R. RICARDO)	1	F 16 F
A	US-A-1 794 715 (C.Y. KNIGHT)	1	
A	FR-A- 319 525 (DE DION et BOUTON)		
A	FR-A- 840 855 (A.B. BOLINDER-MUNKTELL)		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	14-01-1983	CINQUANTINI B.

CATEGORY OF CITED DOCUMENTS

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